The results of fauna recovery from a gas pipeline trench, and a comparison with previously published reports

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ABSTRACT

We removed and recorded vertebrate fauna caught in a 392 km pipeline trench running from Moranbah to Townsville, Queensland. During the entire construction all open trench was checked daily, resulting in the retrieval of 3301 animals comprising 91 species. Because many kilometres of trench were open we devised a simple system of shelter sites in the trench, using material available on the job. These sites had the effect of concentrating the animals for easier retrieval and also considerably reduced mortality. We compare our results with four previously published studies. In all cases reptiles and amphibians account for the majority of removals. The composition of the reptiles removed varied between the five studies, reflecting the regions through which the pipelines passed.

Key words: Queensland, fauna, pipeline construction, shelters, conservation.

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Introduction

Pipelines for gas, water and other materials are now constructed regularly throughout Australia. These pipes are placed into trenches dug by specialised machines. Until the pipes are placed into the trench and filled in, the trench can remain open for days or even weeks. These trenches may traverse many hundreds of kilometres and are in effect pitfall traps ranging from 50 m to more than 50 km in length at any one time.

We are aware of four studies that have provided inventories of fauna recovered from pipeline trenches (Ayers & Wallace 1997; Faulkner 1999; Woinarski *et al.* 2000; Doody *et al.* 2003). The only other inventory that covered the entire trench construction was that of Doody *et al.* (2003); the others carried out selective sampling at various points during the construction.

During 2004 we were engaged by Nacap Australia, a partner in the North Queensland Gas Pipeline Alliance, to carry out fauna recovery from the trench of a gas pipeline to be constructed in Queensland from Moranbah to Townsville. The pipeline route passed through private land (cattle grazing properties) for the most part and did not encroach upon any national parks or conservation reserves. Habitat included grazing land, open woodland, eucalypt forest, brigalow, dry rainforest and cypress pine forest. Here we provide the results of that work, and compare our results with those of the four earlier studies.

Materials and methods

Between March and September 2004 the North Queensland Gas Pipeline Alliance, on behalf of Enertrade, laid a 392 km gas pipeline from Moranbah (7569145N, 603575E) to Townsville (7876696N, 45991E) in the Queensland dry tropics (Figure 1). A 30 m wide right of way (20 m wide in sensitive areas) was cleared to provide access for trench diggers and other machinery. Figure 2 shows the position of the trench and associated materials on the right of way.

Four trench-digging machines were used to dig a trench from 1.5-2 m in depth (Figure 3). The trench digging crews positioned ramps of soil in the trench at about 500 m intervals so that stock and other animals could escape. The pipes were welded together and lowered into the trench, resting on polystyrene pillows or hessian sandbags. The trench was then almost immediately backfilled.

We were on-site during the whole operation. A maximum of 54 km of trench was open, though 20-30 km was usually open at any one time. To cover this length of open trench and to provide cover to prevent animals from overheating or desiccating, a system of humid shelter sites was devised. This involved placing water soaked, sawdust filled hessian sacks at about 250 m intervals on the bottom of the trench (see Figure 4). This provided a humid shelter for large numbers of reptiles, frogs and mammals, and in effect tended to concentrate animals under the sacks.

The daily routine involved checking these shelters and removing any animals under them. At the same time, by checking mid-way between shelters it was possible to gain a complete line of sight to spot any larger animals. All were identified to species level (using Cogger 2000, Wilson and Swan, 2003, Barker and Grigg, 1977 and Menkhorst and Knight 2001) and co-ordinates taken with a Garmin GPS. These data were recorded daily in a database for the Alliance. At the conclusion of the project this information was passed to the Queensland's

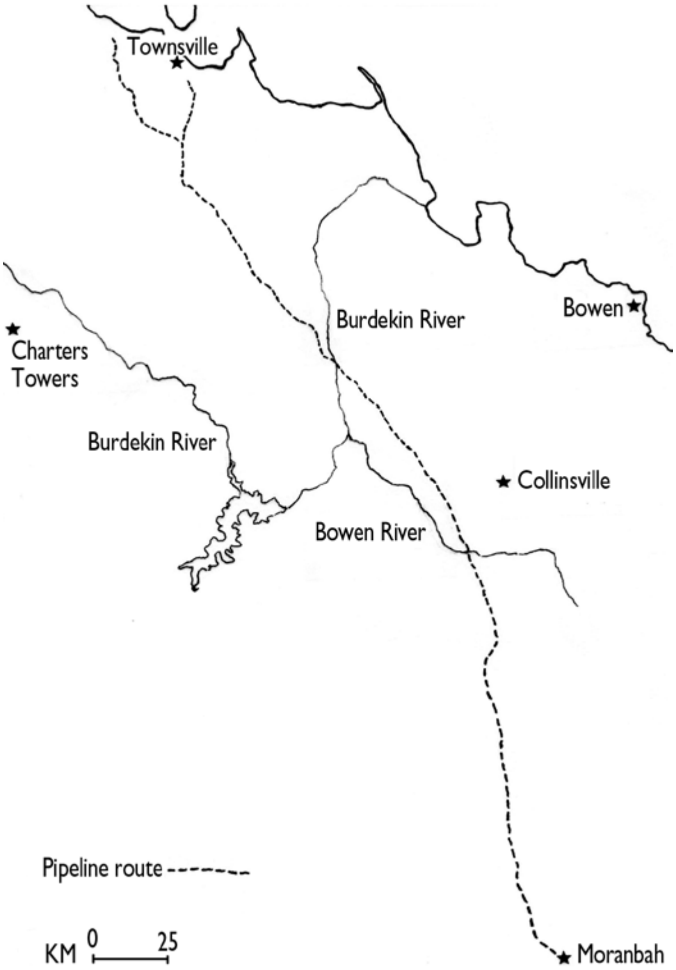
Townsville
Burdekin River
Bowen
Charters Towers
Burdekin River
Collinsville
Bowen River
Pipeline route
KM 0 25
Moranbah

Figure 1: Pipeline route from Moranbah to Townsville.

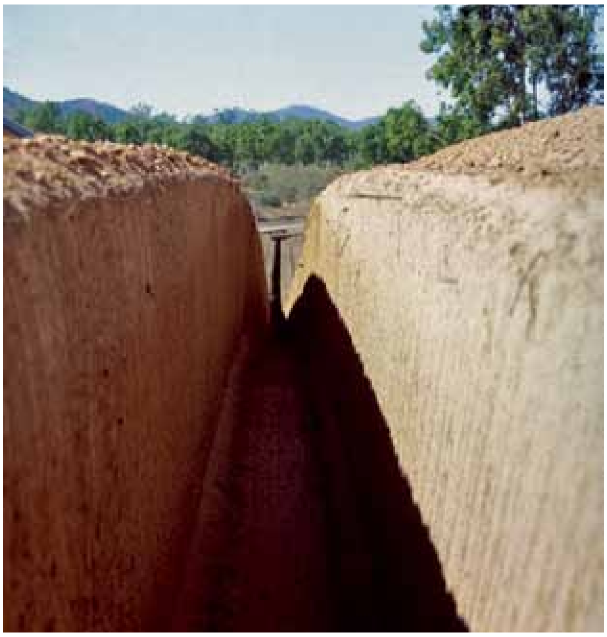

Figure 3: The open trench. Photo, G. Swan.

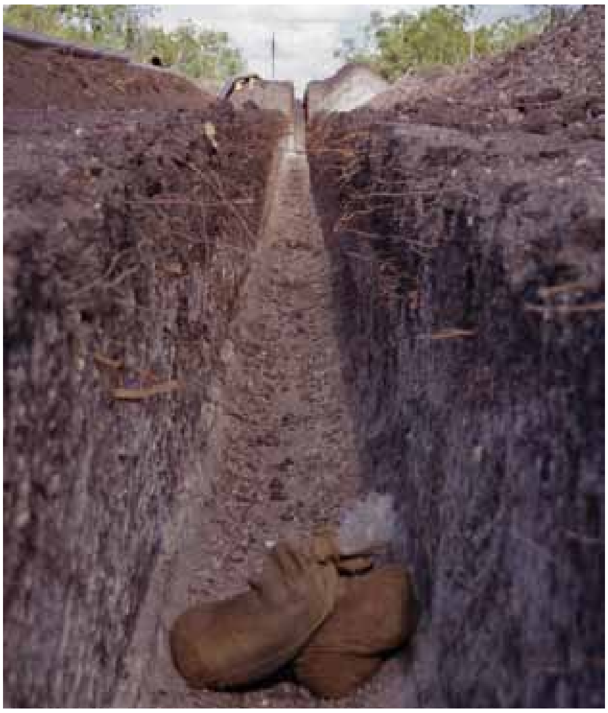

Figure 4: Bags in the trench. Photo, G. Swan.

Environmental Protection Agency (now Department of Environment and Resource Management) for inclusion in their WildNet database. All animals found were released in suitable microhabitats adjacent to their capture spot some 100 m or more from the trench.

All work was carried out from the top of the trench as work safety requirements prohibited working within the trench itself. We used long handled hooks and hoop bags to retrieve the animals. If we were working together one person was permitted to enter the trench briefly to retrieve an animal that could not be removed with the hook and bag. In addition to checking the bags each day we would also walk along 10-15 km of trench checking

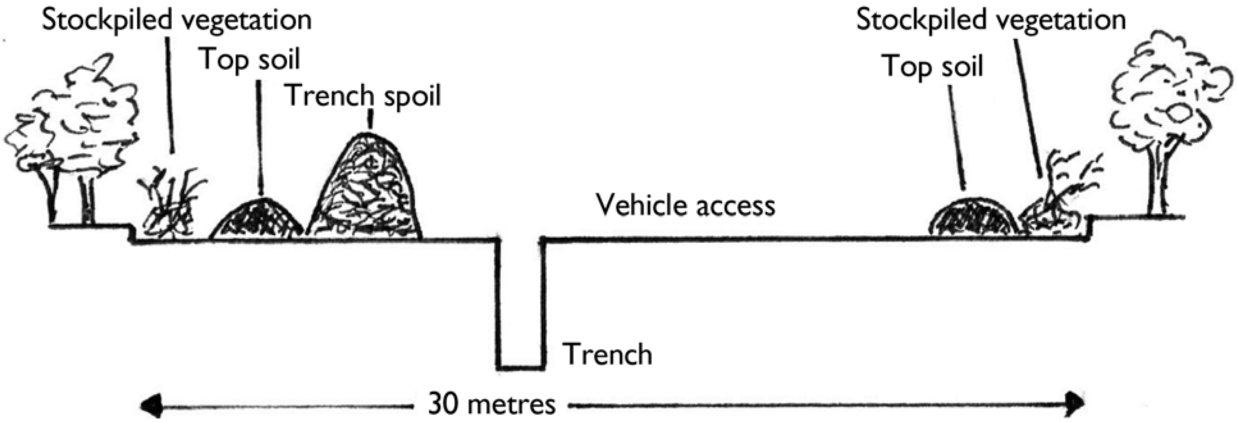
Stockpiled vegetation
Top soil
Trench spoil
Vehicle access
Stockpiled vegetation
Top soil
Trench
30 metres

Figure 2: Schematic cross-section of the Right of Way.

for animals not sheltering under the bags. These stretches were selected on the basis of the number of animals found under bags and sections of trench scheduled to be backfilled. We therefore concentrated on areas where a large number of animals had already been removed, turning any earth clods or other debris in the trench to locate animals sheltering there. Where possible, any dead animals were preserved and lodged with the Queensland Museum.

Frogs were sometimes found in the open trench away from the bags, often suffering from dehydration. To rehydrate the frogs we carried a bucket in each vehicle with a small amount of water in the bottom. Frogs were placed in the bucket and allowed to soak before release. Their powers of rehydration were truly amazing, and many frogs we felt sure were dead, revived with no apparent ill effects. In one case a frog was removed from the trench so desiccated that it could not be identified at genus let alone species level. It was placed in the bucket in the hope that it would absorb sufficient water to allow us to identify the corpse. An hour later not only was it recognisable as a Northern spadefoot frog *Notaden melanoscaphus*, but it was also hopping about in the water.

Results

We removed 91 vertebrate species from the open trench during the laying of the pipe (Table 1). Reptile species were the most common, comprising 56 species (62%), frogs comprised 18 species (20%), mammals 14 species (15%), and birds 3 species (3%). Exotic animals removed from the trench were rabbits, cats, mice, cane toads, cattle and one horse. We did not record locations or numbers of these species but, apart from the Cane toad *Rhinella marina*, few feral animals were encountered. Cattle entered or fell into the trench, but most found their way out.

It must also be assumed that some animals found their way into the trench on more than one occasion. Without marking each individual it was impossible to tell the extent to which this might be happening. However, any particular section of trench was usually not open for more than 3 or 4 days, and to minimize re-entry, animals were relocated in appropriate refuges up to 200 m from the trench, and when possible on the spoil-side.

Of the 3301 animals recovered, 3275 (99.15%) were alive and 26 (0.85%) were dead. Some were killed during trenching operations, a few drowned and others died from exposure to the sun. We were continually surprised at the high numbers of very small animals found in the trench. Considering the obstacles presented by the right of way (Figure 2) it is a wonder that any animals at all got as far as the trench.

Invertebrates were removed opportunistically. The Whistling spider *Selenotypus* sp. was encountered occasionally and relocated, as were specimens of the Giant Burrowing cockroach *Macropanesthia rhinoceros*. Three Freshwater crabs *Austrothelphusa transversa* were a surprise find (Figure 5).

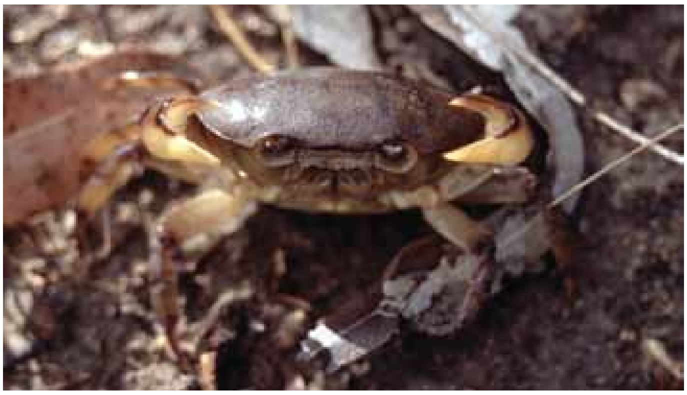

Figure 5: Freshwater crab in the trench. Photo, G. Swan.

Among reptiles 800 snakes were removed. The most frequently recorded species was the Freshwater snake *Tropidonophis mairii* of which 266 were rescued. It was not uncommon in some localities to find 8-10 individuals under one bag. The next most often encountered snake was the Ornamental snake *Denisonia maculata* with 103 removed from the trench. This species is endemic to Queensland and is listed as Vulnerable (State, Federal and IUCN listings). It was, however, surprisingly abundant in specific habitats along the pipeline (Wilson & Swan, in prep.).

The most frequently recorded lizard was the Box-patterned gecko *Lucasium steindachneri* with 216 recorded. Although 13 species of skinks were recorded, none were found in large numbers, but it may be that the smaller fossorial species avoided detection in loose spoil on the floor of the trench.

Two widespread species of reptile that we expected but did not record were the Mulga snake *Pseudechis australis* and the Yellow-spotted monitor *Varanus panoptes*. They were not seen on access tracks or local roads and possibly are victims of the Cane toad *Rhinella marina*. Aboriginal monitors employed on the pipeline mentioned that the Yellow-spotted monitor had become less common in recent years.

Among frogs, Green tree frogs *Litoria caerulea* predominated with 540 recovered, and they occurred along almost the entire length of the pipeline. They were probably outnumbered by cane toads, but we kept no count of these.

Among mammals, most occurred in the trench in low numbers except for the Stripe-faced dunnart *Sminthopsis macroura* and the Long-tailed planigale *Planigale ingrami* with 58 and 43 individuals, respectively.

For birds, only 3 were found in the trench and these were all fledglings that appeared to be unable to fly out of the narrow trench.

Table 1. Fauna removed from the pipeline trench between 4 April and 9 August 2004.

Group/species	# removed
Snakes:	
Antaresia maculosa Spotted python	63
Aspidites melanocephalus Black-headed python	12
Morelia spilota Carpet python	2
Dendrelaphis punctulata Green tree snake	7
Tropidonophis mairii Freshwater snake	266
Ramphotyphlops affinis Small-headed blind snake	8
Ramphotyphlops ligatus Robust blind snake	14
Ramphotyphlops unguirostris Claw-snouted blind snake	14

Group/species	# removed
Brachyurophis australis Australian coral snake	4
Cryptophis boschmai Carpentaria snake	83
Cryptophis nigrostriatus Black-striped snake	12
Demansia psammophis Yellow-faced whipsnake	24
Demansia torquata Collared whipsnake	1
Demansia vestigiata Lesser black whipsnake	38
Denisonia maculata Ornamental snake	103
Furina diadema Red-naped snake	7
Hoplocephalus bitorquatus Pale-headed snake	7
Pseudonaja textilis Eastern brown snake	28
Suta suta Curl snake	102
Vermicella annulata Bandy-bandy	5
Lizards:	
Diplodactylus conspicillatus Fat-tailed gecko	77
Diplodactylus vittatus Eastern stone gecko	14
Gehyra dubia Dubious dtella	91
Heteronotia binoei Bynoe's gecko	92
Lucasium steindachneri Box-patterned gecko	215
Nephrurus asper Prickly knob-tailed gecko	5
Oedura castelnaui Northern velvet gecko	18
Oedura monilis Ocellated velvet gecko	5
Oedura rhombifer Zigzag velvet gecko	3
Strophurus williamsi Eastern spiny-tailed gecko	38
Delma tincta Painted snake-lizard	1
Lialis burtonis Burton's snake-lizard	16
Pygopus schraderi Eastern hooded scaly-foot	9
Amphibolurus burnsi Burns' dragon	5
Chlamydosaurus kingii Frilled lizard	4
Diporiphora australis Tommy roundhead dragon	116
Pogona barbata Eastern bearded dragon	38
Tympanocryptis cf. *lineata* Lined earless dragon	1
Varanus scalaris Spotted tree monitor	3
Varanus tristis Freckled monitor	2
Carlia munda Rainbow skink	7
Carlia pectoralis Rainbow skink	16
Carlia schmeltzii Robust rainbow skink	3
Cryptoblepharus plagiocephalus Fence skink*	3
Cryptoblepharus pulcher Pretty snake-eyed skink	2
Ctenotus robustus Eastern striped skink	23
Ctenotus strauchii Striped skink	3
Ctenotus cf *taeniolatus* Copper-tailed skink	7
Eremiascincus fasciolatus Narrow-banded sandswimmer	3
Lerista fragilis Eastern mulch slider	2
Menetia greyii Common dwarf skink	1
Menetia timlowi Litter skink	1
Tiliqua scincoides Eastern blue-tongued skink	1
Turtles:	
Chelodina canni Cann's long-necked turtle	4
Chelodina longicollis Eastern snake-necked turtle	1
Chelodina rugosa Northern long-necked turtle	1
Frogs:	
Cyclorana brevipes Short-footed frog	12
Cyclorana cultripes Knife-footed frog	11
Cyclorana novaehollandiae Eastern snapping frog	143
Cyclorana platycephala Water-holding frog	1
Limnodynastes tasmaniensis Spotted grass frog	78
Limnodynastes terraereginae Northern banjo frog	1
Litoria alboguttata Green-striped frog	79
Litoria bicolor Northern sedge frog	1
Litoria caerulea Green tree frog	540
Litoria inermis Peter's frog	63
Litoria latopalmata Broad-palmed rocket frog	1
Litoria nasuta Rocket frog	3
Litoria rothii Red-eyed tree frog	15
Litoria rubella Desert tree frog	383
Notaden bennettii Holy cross frog	2
Notaden melanoscaphus Northern spadefoot frog	2
Platyplectrum ornatum Ornate burrowing frog	168
Uperoleia lithomoda Gungan frog	25
Mammals:	
Aepyprymnus rufescens Rufous bettong	5
Antechinus flavipes Yellow-footed antechinus	1
Isoodon macrourus Northern Brown bandicoot	1
Macropus agilis Agile wallaby	1
Planigale ingrami Long-tailed planigale	43
Planigale maculata Common planigale	11
Pseudomys deliculatus Delicate mouse	5
Pseudomys sp. Native rodent	2
Rattus sordidus Canefield rat	1
Rattus tunneyi Pale field rat	1
Sminthopsis crassicaudata Fat-tailed dunnart	2
Sminthopsis macroura Stripe-faced dunnart	58
Tachyglossus aculeatus Echidna	6
Unidentified Native rodent	2
Birds:	
Entomyzon cyanotis Blue-faced honeyeater	1
Grallin cyanoleuca Magpie lark	1
Myiagra sp. Flycatcher	1

* Subsequently reviewed taxonomically. The species recorded was probably *Cryptoblepharus pannosus* or *C. australis*

Table 2. Summary of fauna removed from trench.

Taxon	# of individuals	# of species
Snakes:	800	20
Lizards:	825	33
Turtles:	6	3
Frogs:	1528	18
Mammals:	139	14
Birds:	3	3
TOTAL:	3301	91

Discussion

To make a more effective comparison with the previously published results (Table 3) that included exotics, we have only compared records of native species. Therefore, we have adjusted their figures as follows:

Ayers & Wallace: mammal species reduced by 2 and individuals by 36;

Faulkner: mammal species reduced by 2 and individuals by 10;

Doody *et al.*: mammal species reduced by 7 and individuals by 47; and

Woinarski *et al.*: no adjustments.

Ayers & Wallace (1997) also included scats that were identified and a slough in their count. As our results only include rescued animals and no incidental sightings or signs, these have also been excluded. Doody *et al.* (2003) also recorded one fish that we have excluded from the comparison.

Ayers & Wallace (1997) reported on 256 km, this being the number of km searched. However, like us they searched some sections of trench more than once. The actual length of pipeline involved in their study was 172 km, and we have used this figure to provide a better comparison with the other studies, where pipeline kilometres were cited. Our experience was that some sections of trench would be checked several times over a number of days depending upon how soon pipe was laid into the trench and covered.

Only the present study and that of Doody *et al* (2003) covered the entire trench digging operation with personnel present at all times. The other studies were either over limited periods of time and/or specific stretches of trench.

A direct comparison between the five studies is difficult because of variables such as geographic location (Ayers & Wallace – western NSW; Faulkner – central western NSW; Woinarski *et al* – monsoonal tropics NT; Doody *et al* – southeastern Australia between Melbourne and Sydney; this study - dry tropics Qld), time of year, daily weather conditions, climatic conditions (drought or normal seasons) the skill of the fauna handlers, safety considerations, and the time allocated to cover extensive areas of open trench.

As with all of the previous studies, reptiles and amphibians dominated the fauna rescued. In three of the studies (Ayers and Wallace 1997, Woinarski et al. 2003 and this study) reptiles were more abundant than frogs, while Doody *et al.* (2003) and Faulkner (1999) recorded more frogs than reptiles. This is possibly due to the geographical location of the pipelines and the weather conditions in the regions at the time of the studies. There was considerable variation in the abundance of the lizards. Doody *et al.* (2003) recorded a large number of skinks followed by dragons. Ayers and Wallace (1997) recorded skinks as the most abundant lizard followed by geckos, while Woinarski et al. (2003) and this study had geckos as the most abundant followed by dragons. Doody *et al.* (2003) experienced wet weather and flooded trenches which possibly prevented small skinks from hiding in loose soil. Our study had predominantly dry weather and the bottom of the trench in many areas had loose soil in the bottom. We have also noticed in subsequent pipeline jobs that many *Ctenotus* skinks are adept at climbing the vertical walls of the trench. Snakes were plentiful throughout this study, which is probably due to the greater diversity of snakes in northern Australia. The lower number of snakes in the Woinarski et al. (2003) study may well be due to their study only extending over 74 km.

Table 3. Comparison with previous studies. Figures within () are number of species.

	Km	Reptiles	Frogs	Mammals	Birds	Total No.	Average No. per km	Mortality (%)
Ayers and Wallace (1997)	172	374(39)	30(8)	173(12)	7(3)	584	3.40	41.8
Faulkner (1999)	255	102(14+)	175(6+)	7(2)	5(3+)	289	1.13	54.3
Woinarski et al. (2002)	74.2	185(29)	11(1)	151(9)	2(1)	349	4.70	11.1
Doody et al. (2002)	792	2960(45)	4103(19)	207(17)	31(14)	7301	9.22	3.06
This study	392	1631(56)	1528(18)	139(14)	3(3)	3301	8.42	0.85

Table 4. A comparison of lizard & snake abundance during the five studies.

	This study	Doody *et al.* 2003	Woinarski *et al.* 2002	Faulkner 1999	Ayers and Wallace 1999
Lizards					
Geckos	558	4	78	3	90
Snake-lizards	26	4	22	-	28
Dragons	164	296	46	13	55
Goannas	5	9	-	-	13
Skinks	72	2406	13	17	99
Snakes					
Pythons	77	-	4	-	-
Blind snakes	36	-	3	4	13
Colubrids	273	-	-	-	-
Elapids	414	150	17	58	76

Do some species avoid the trench and so never get recorded? Given the diversity of animals found, our results seem reasonably comprehensive. But some animals can escape from the trench without too much trouble. Some climb out, others move along the trench and escape via the ramps. Possibly a significant number do this if tracks in dust in the bottom of the trench is any indicator. Small mammals, lizards and snakes all seemed to be able to travel the maximum 500 m to get to a ramp quite easily. So numbers caught probably under-represent the real abundance. Because our methodology dictated working from the top of the trench, there is no doubt many small fossorial animals in the trench were not located because they had burrowed into loose soil on the trench floor or had effectively concealed themselves in some other manner. But such trenches effectively catch a wide range of fauna and can provide wildlife authorities with valuable data from areas not extensively sampled.

Mortality differed significantly between the studies, from 54.3% for Faulkner (1999) to 0.85% in this study, and is obviously affected by climatic conditions, frequency and timing of trench checking, and the habitat. Direction of trench and time of year also exert an influence on whether some sections may be without shade during a period of the day. The placing of bags within the trench and the concentration of animals under these bags was successful in keeping mortality to a minimum.

Predation between animals in the trench was not often observed and was limited to a few instances of frogs being eaten by snakes, and a Spotted python *Antaresia maculosa* being consumed by a Black-headed python *Aspidites melanocephalus*.

Potential predators and prey were frequently found under the same shelter which suggests, for prey species at least, that procurement of shelter was of greater importance than fear of being eaten. We cannot rule out that predators in such situations were already sated upon sheltering prey, although no instance of regurgitation of freshly eaten prey by predators, was observed.

Predation of animals in the trench probably did occur as cat and dog footprints on the trench floor indicate that they periodically moved along the trench, possibly in search of prey. No killed and partly eaten animals were found.

The methodologies and protocols varied among the studies. Doody *et al.* (2003) found that late morning was their ideal time to rescue animals in a cooler climate, and flooded trenches were a major problem. In our case the ideal time was early morning with heat and dehydration being the concerns in the tropics. In our opinion careful consideration needs to be given prior to commencement of trenching as to the most effective methodologies and these should be adaptive to take local conditions at the time of the work into account.

Consideration must also be given to other issues such as dealing with dead animals (e.g., what should be preserved as voucher specimens for museums); dealing with orphaned or injured animals (e.g., are there vets/wildlife carers available in the region); and what information will be recorded for each animal removed from the trench and who will get this information.

There is also a need, given the trans-continental pipeline infrastructure that continues to develop, for a national best-practice approach to wildlife and other environmental issues.

These projects offer unique opportunities to gather information not only on species distributions but also on abundance.

Acknowledgements

Graeme Hogarth, Rick Boreham, and Norm Sewell of the North Queensland Gas Pipeline Alliance, and the guys on the construction crews who accepted with good grace the antics of the 'snake whisperers'. Nacap Australia, who encouraged us to record our data and ensured we were well resourced. The two referees whose input improved the paper considerably.

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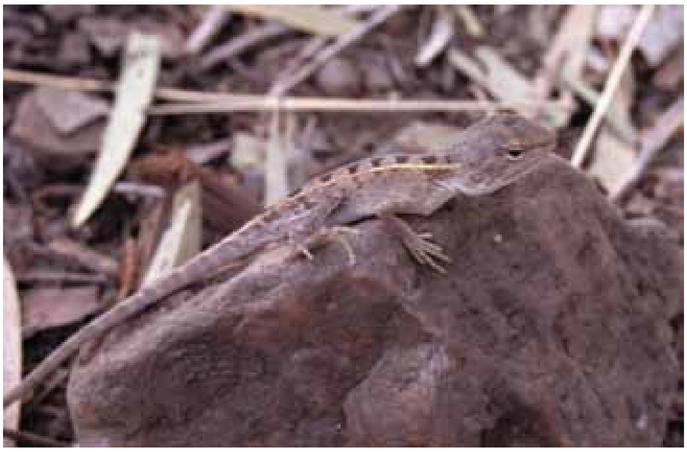
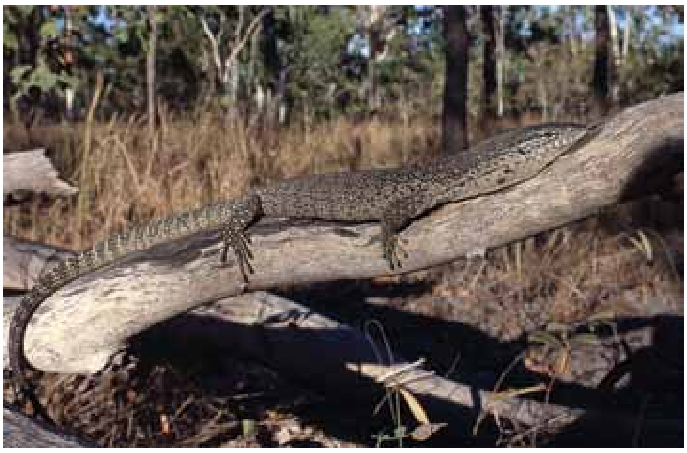
APPENDIX I



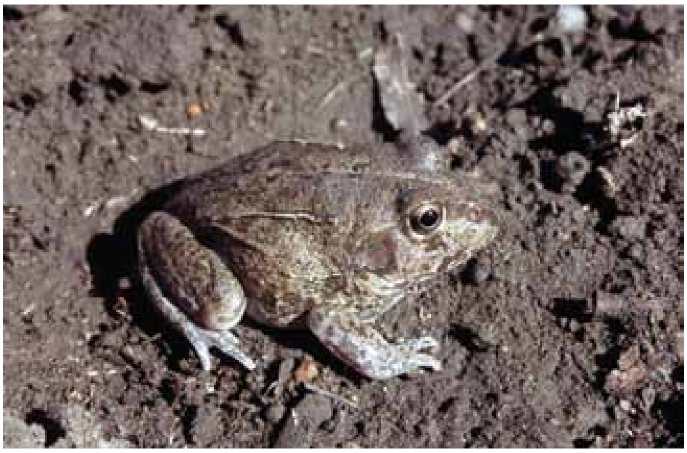
Tommy round head *Diporiphora australis.*

Photo, G. Swan.



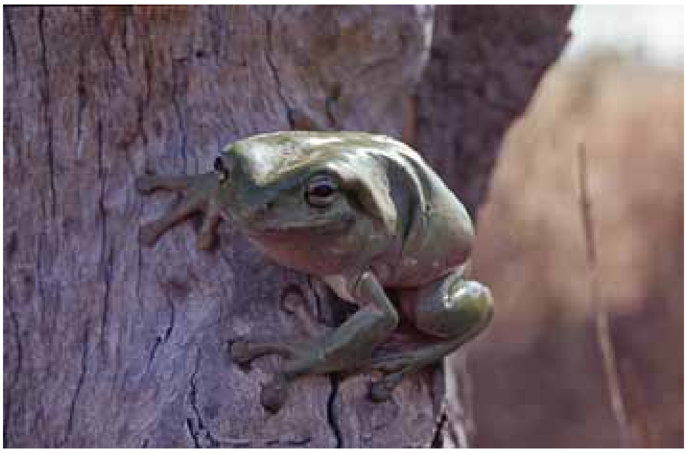
Spotted tree monitor *Varanus scalaris.*

Photo, G. Swan.



Eastern snapping frog *Cyclorana novaehollandiae.*

Photo, G. Swan.



Green tree frog *Litoria caerulea.*

Photo, G. Swan.

APPENDIX I

Cane toads *Rhinella marina* under a bag.

Photo, G. Swan.

Black-headed python *Aspidites melanocephalus*

Photo, G. Swan.

Lesser black whipsnake *Demansia vestigiata*

Photo, G. Swan.

Fat-tailed gecko *Diplodactylus conspicillatus*

Photo, G. Swan.

Prickly knob-tailed gecko *Nephrurus asper*

Photo, G. Swan.